

Testing for Stray Current Corrosion in Earth Covered Magazines with EOP

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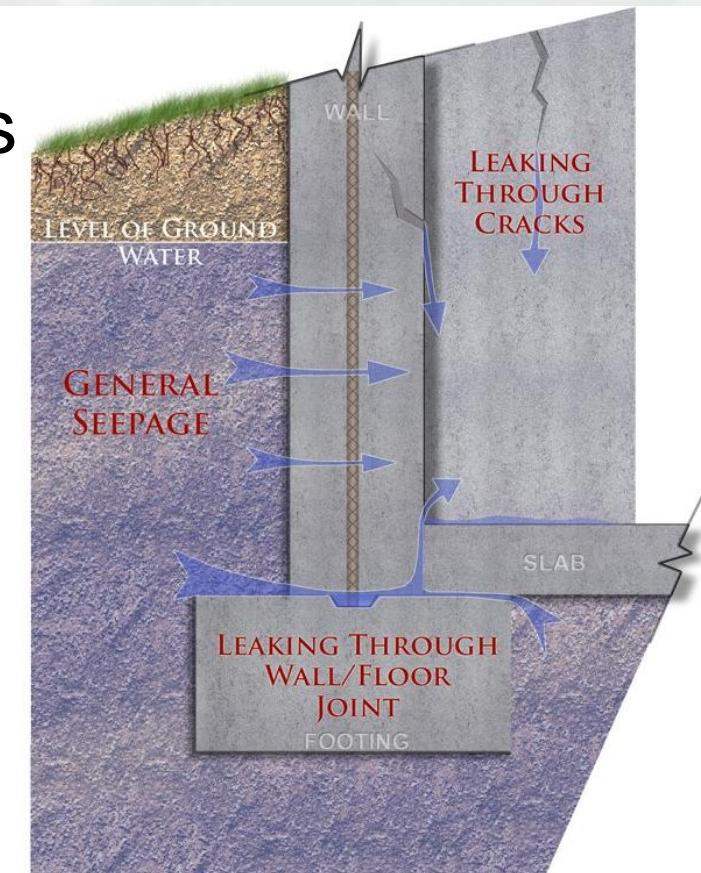
Outline

- EOP Technology
- Stray Current
- Stray Current Testing
- Test Findings
- Recommended Test Procedures
- Conclusion



Background

- Underground Structures inherently have moisture intrusion problems
- Large volumes of water seep through the concrete
 - ▶ Walls, floors, and ceilings
 - Rising damp
 - Wicking
 - High external head
 - ▶ Joints and cracks

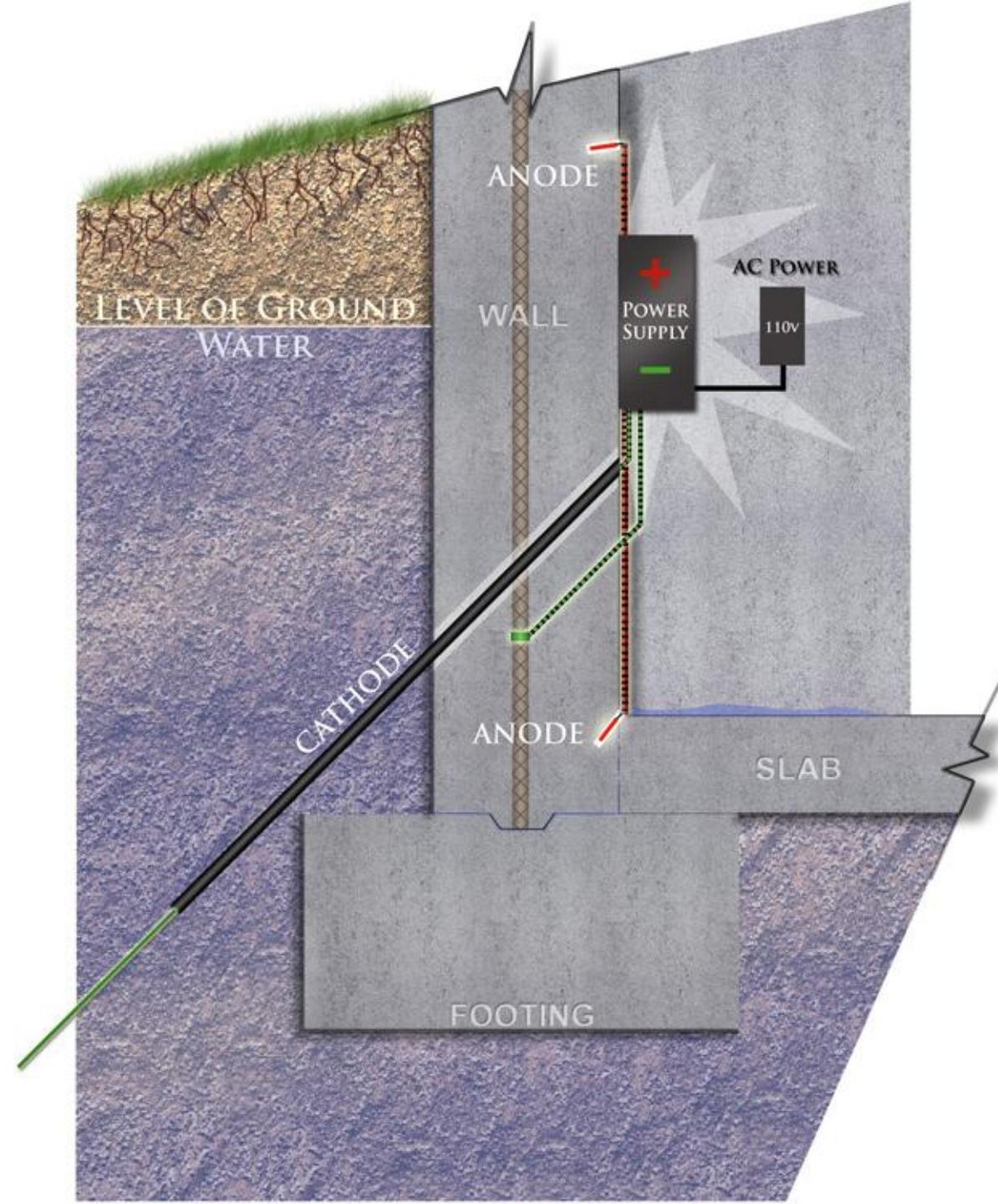


Background

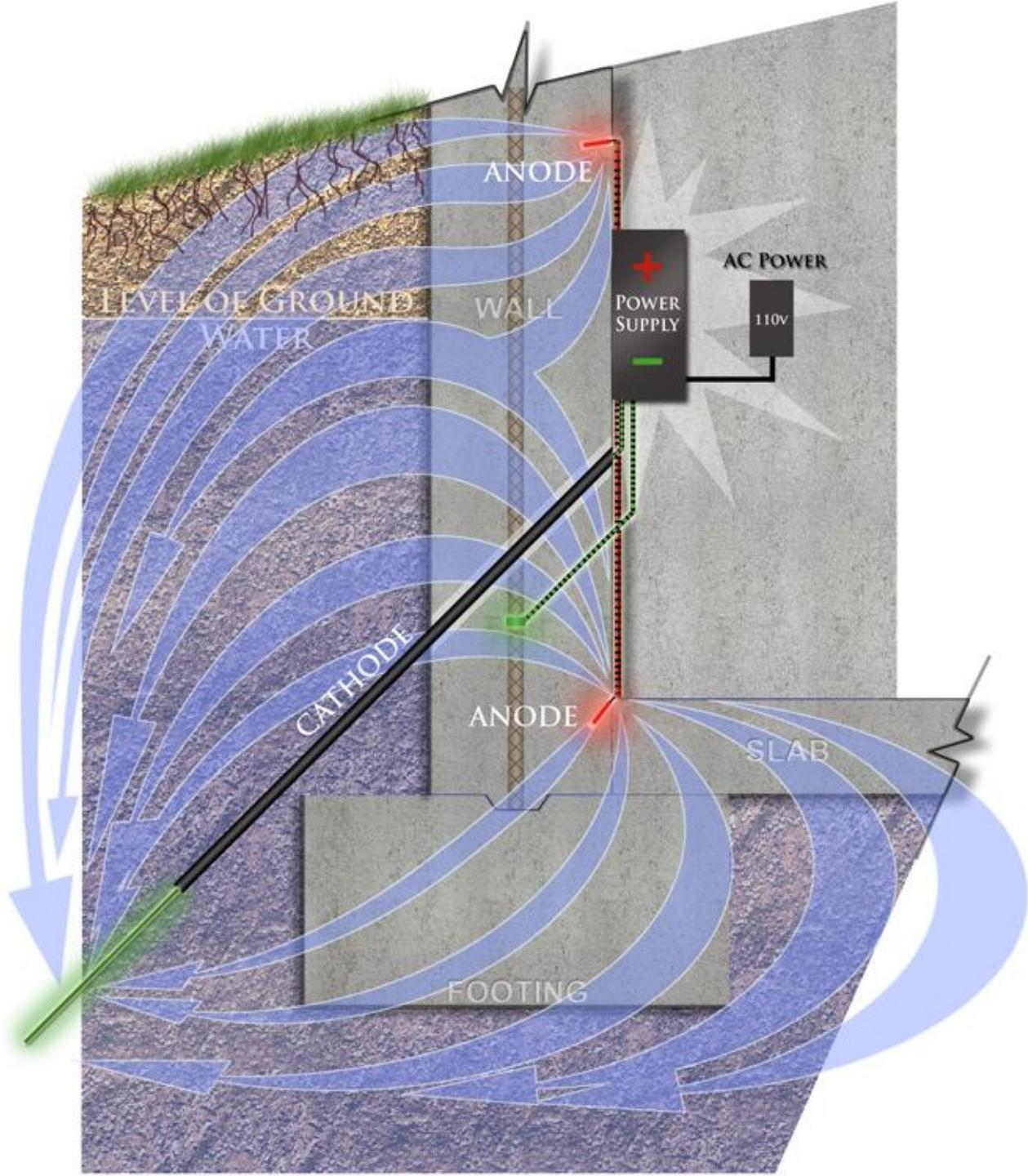
- The water intrusion causes corrosion
 - ▶ Structural steel
 - ▶ Stored assets making many unusable
 - ▶ Mold and poor air quality



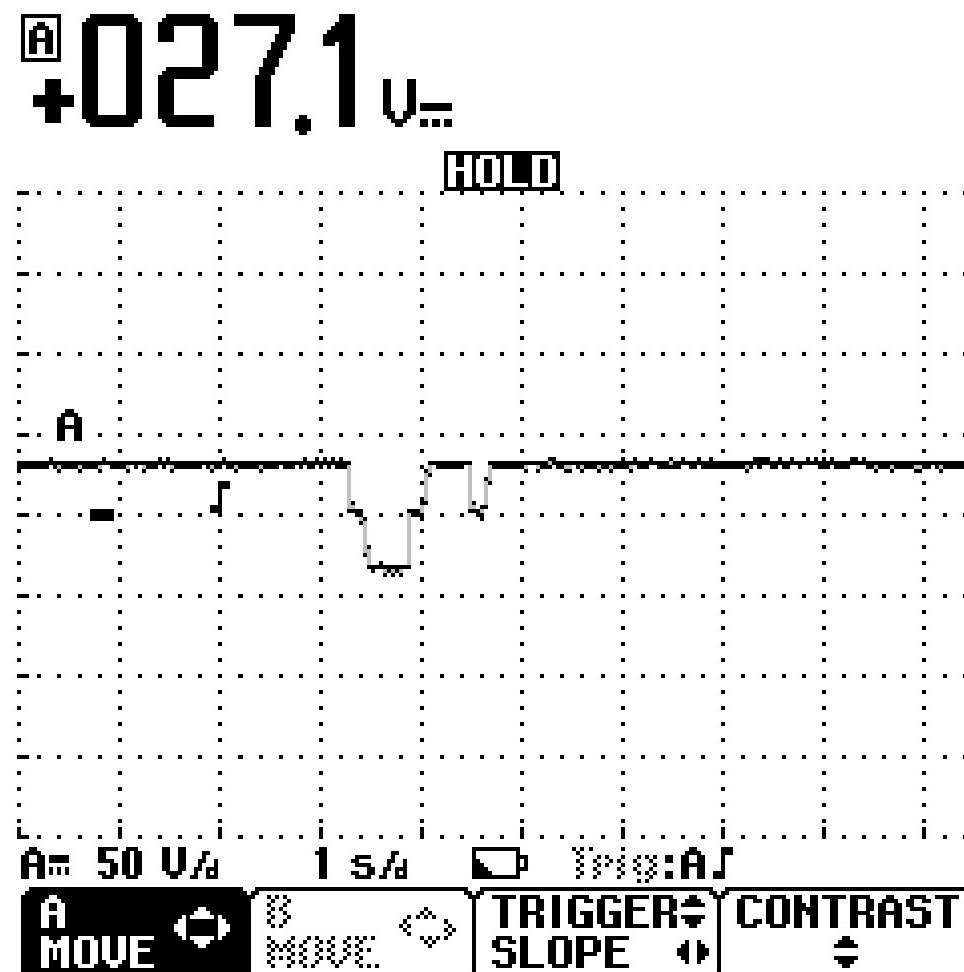
Typical EOP Installation



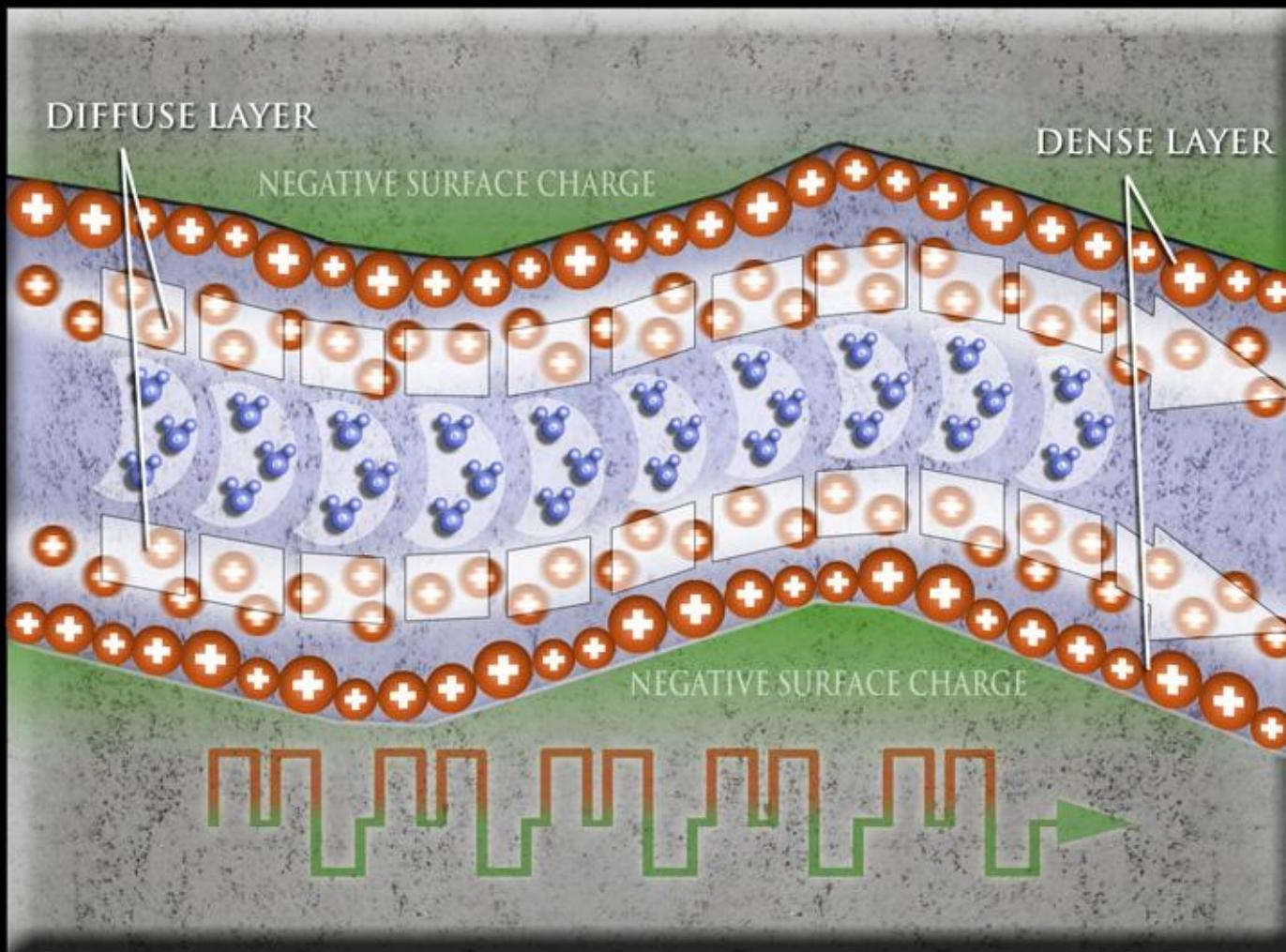
When activated
EOP sets up an
electric field that
creates an
osmotic force
within the
concrete pores
that counters
head forces



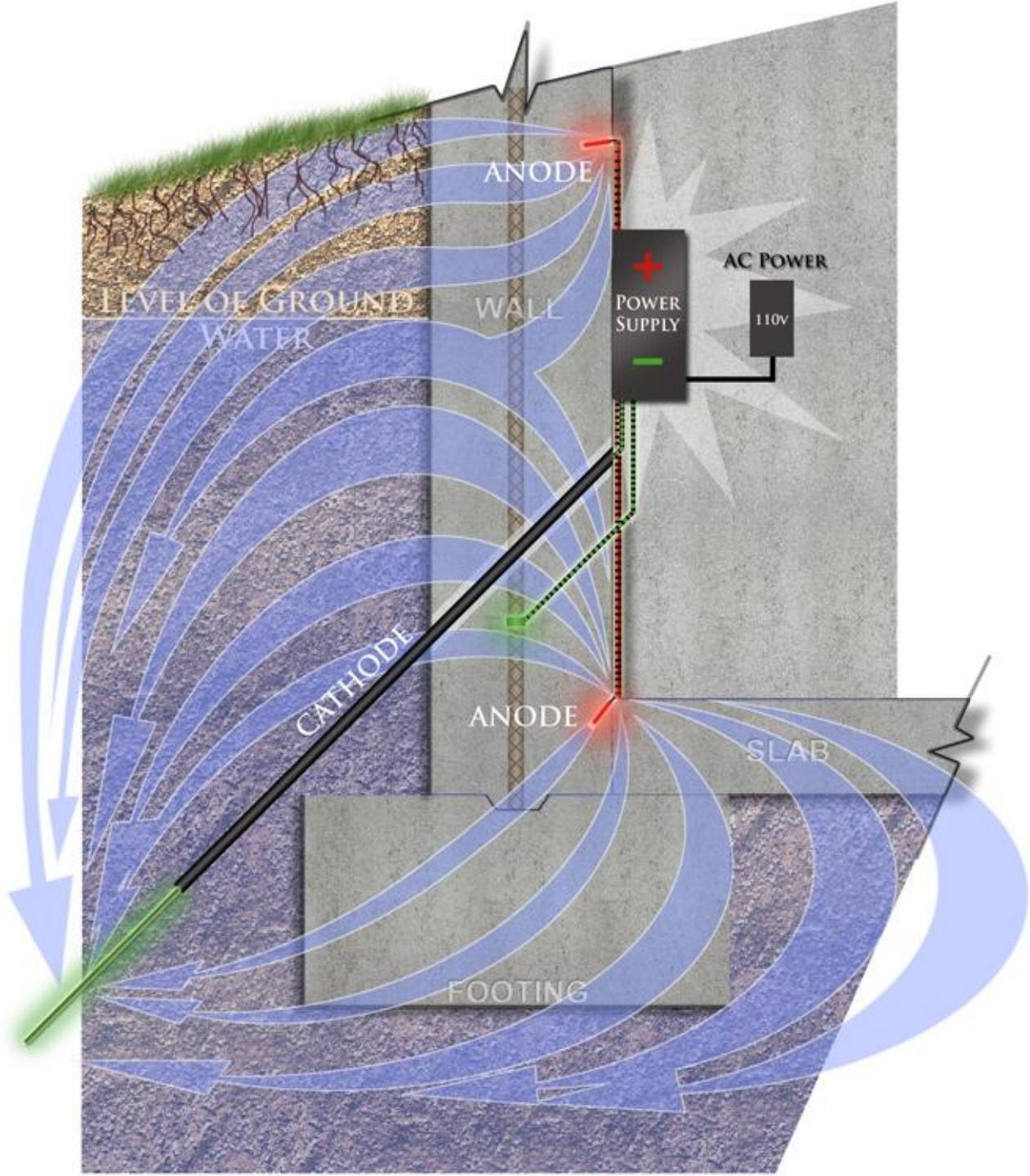
Typical EOP Pulse



EOP Pulse Effect



DC current has potential for causing corrosion of metallic objects between anode and cathode

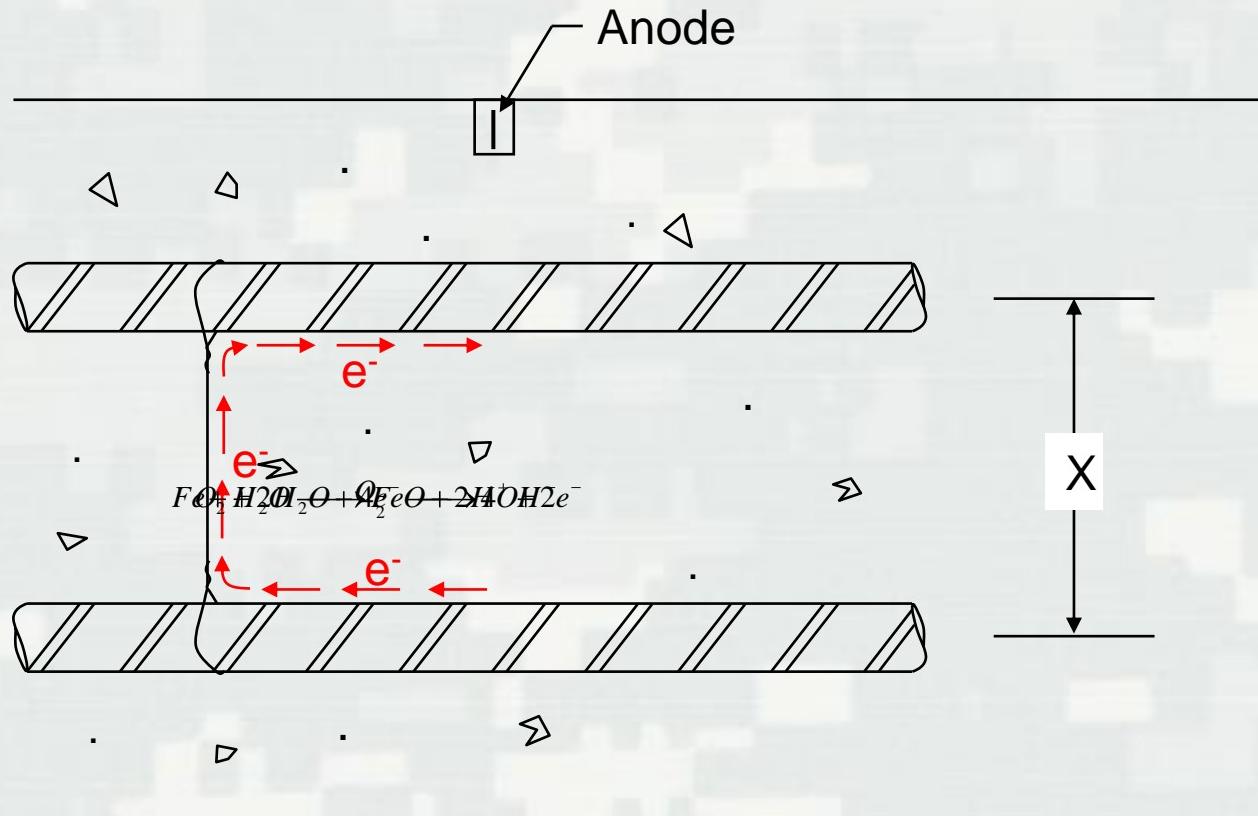
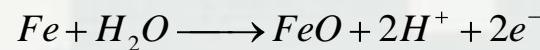


Stray Current

Cathodic Reaction



Anodic Reaction



(To remote cathode)

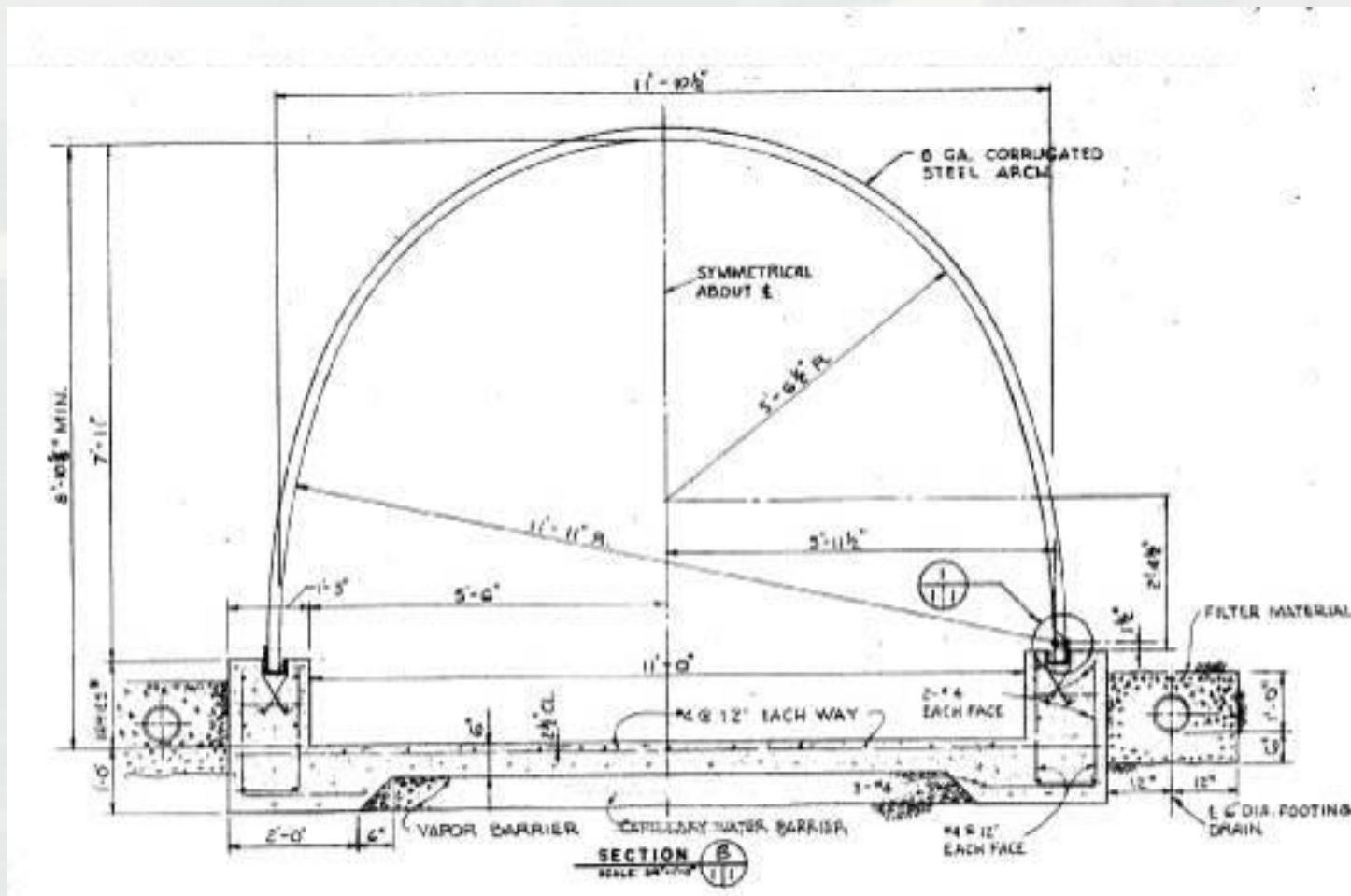


EOP Technology Demonstration

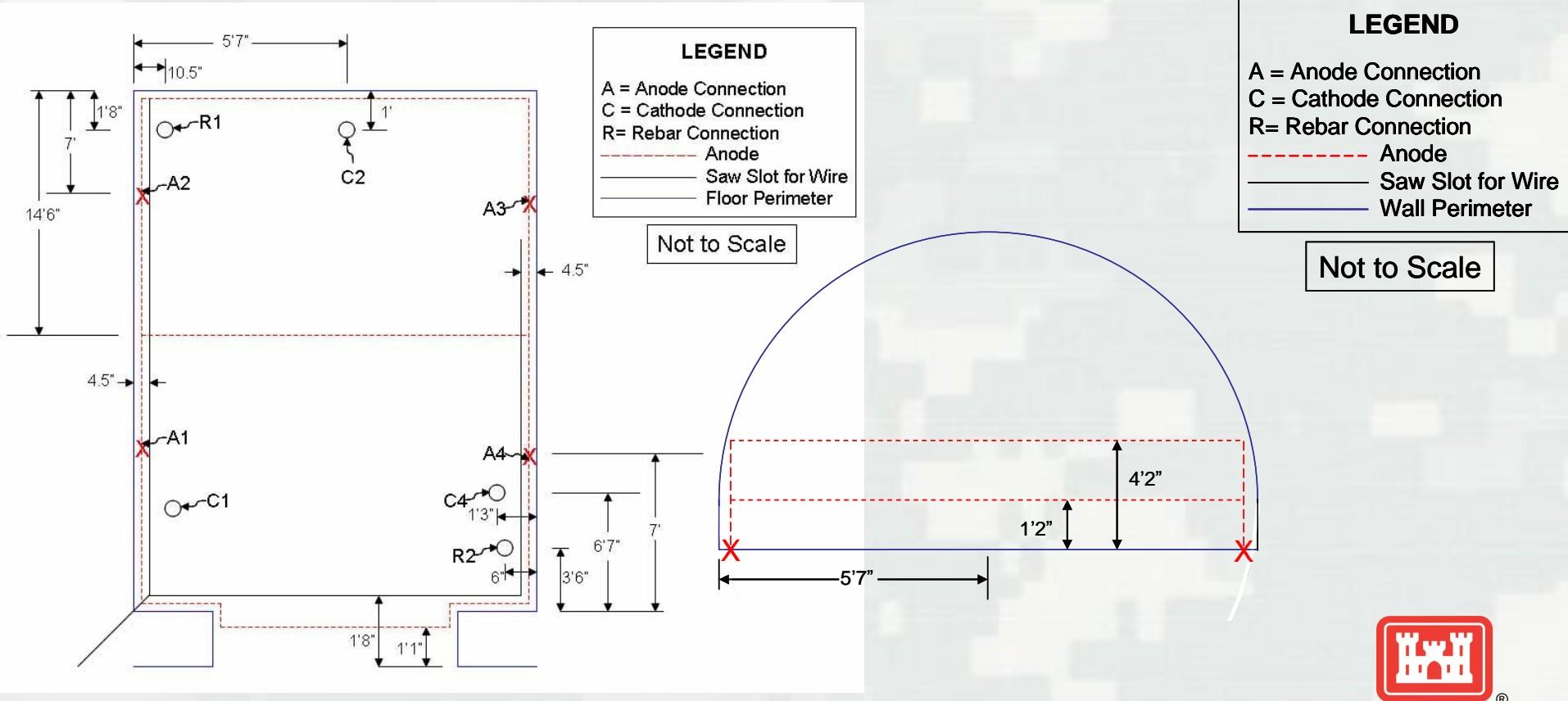


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EOP Technology Demonstration



EOP Technology Demonstration



EOP Technology Demonstration



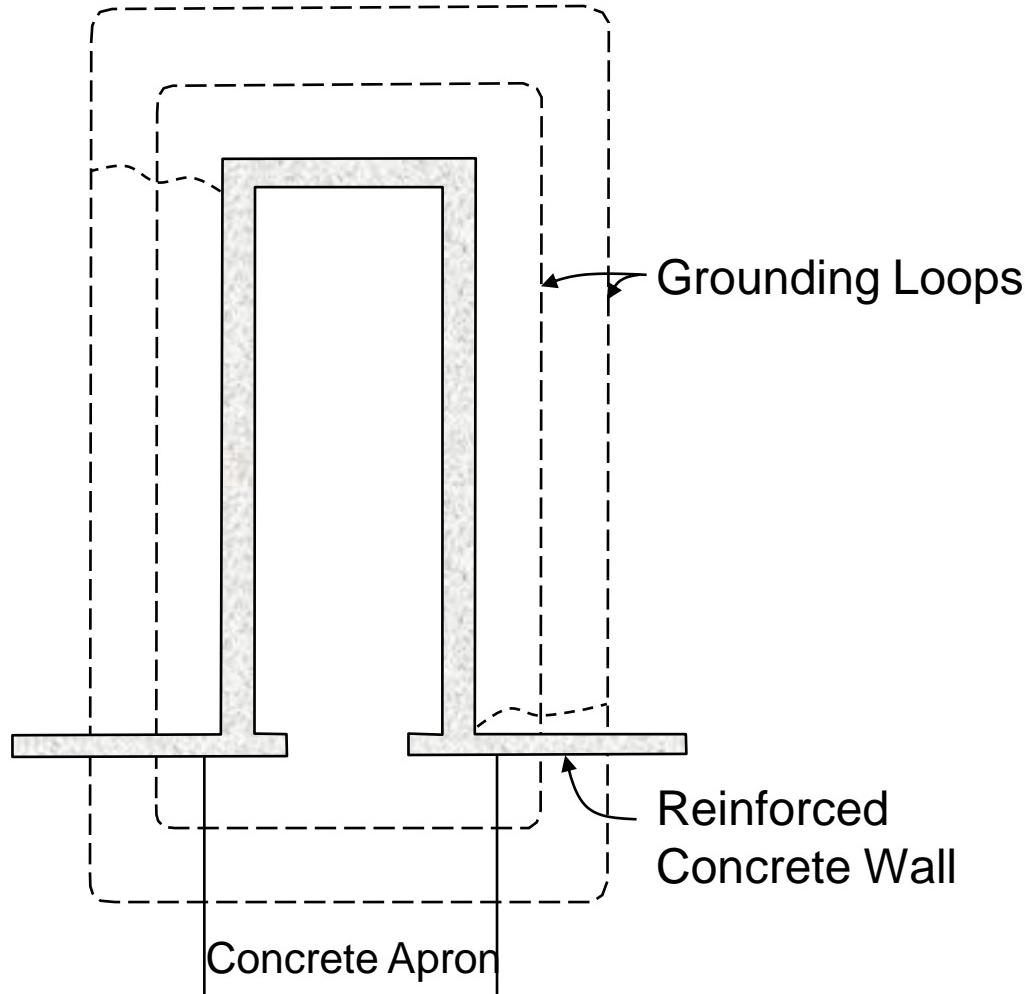
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Field Tests and Demonstrations in ECMs

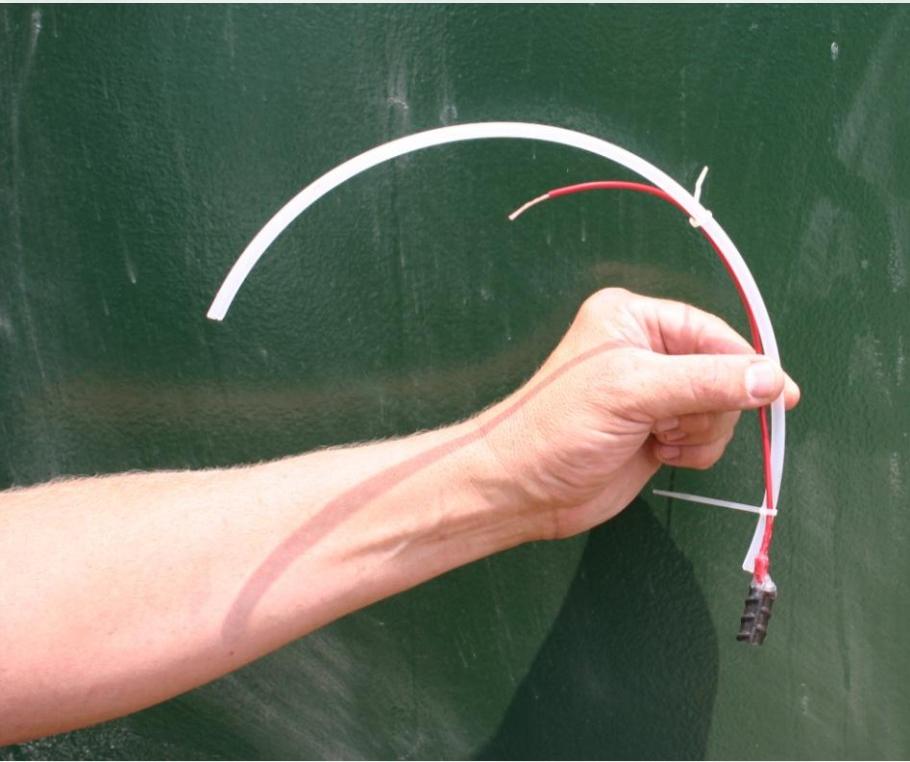
Spark potential of steel arch	None
Spark potential of pallets on floor	None
Spark potential between pallets and arch	None
Hydrogen generation	None
Affects on LPS 	None w/ majority of current to rebar
Water intrusion	Stopped
Electromagnetic radiation	None detected
RF emission	None detected



Typical ECM LPS Layout

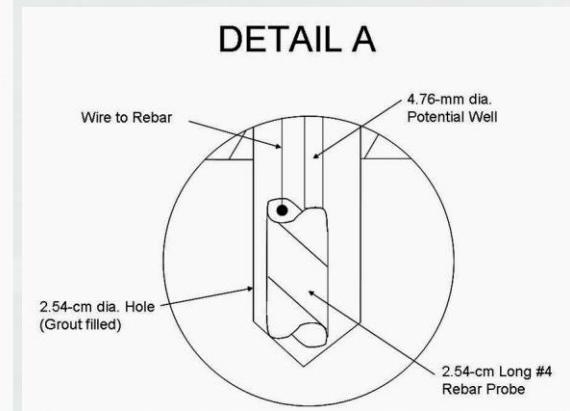
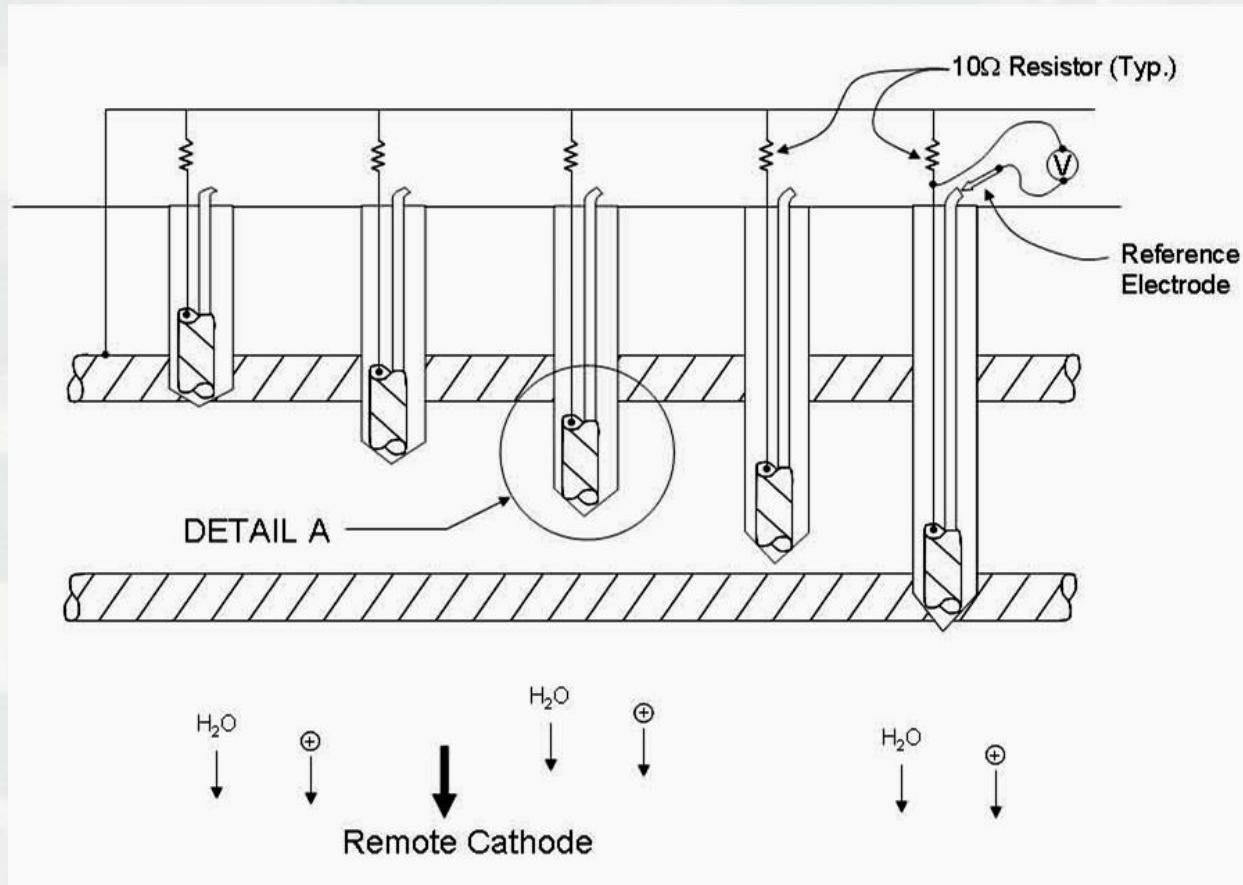


Stray Current Test Setup



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Stray Current Test Setup



Estimated Current Requirements to Steel

X (cm)	Concrete Resistivity, $\Omega\text{-cm}$			
	10,000	15,000	20,000	25,000
2.	0.00 mA (0%)	0.00 mA (0%)	0.00 mA (0%)	0.03 mA (2.2%)
4.	0.00 mA (0%)	0.06 mA (4.2%)	0.12 mA (8.0%)	0.18 mA (12.1%)
6.	0.06 mA (4.2%)	0.16 mA (10.3%)	0.24 mA (16.0%)	0.33 mA (21.7%)
8.	0.12 mA (8.0%)	0.24 mA (16.0%)	0.36 mA (23.8%)	0.47 mA (31.6%)

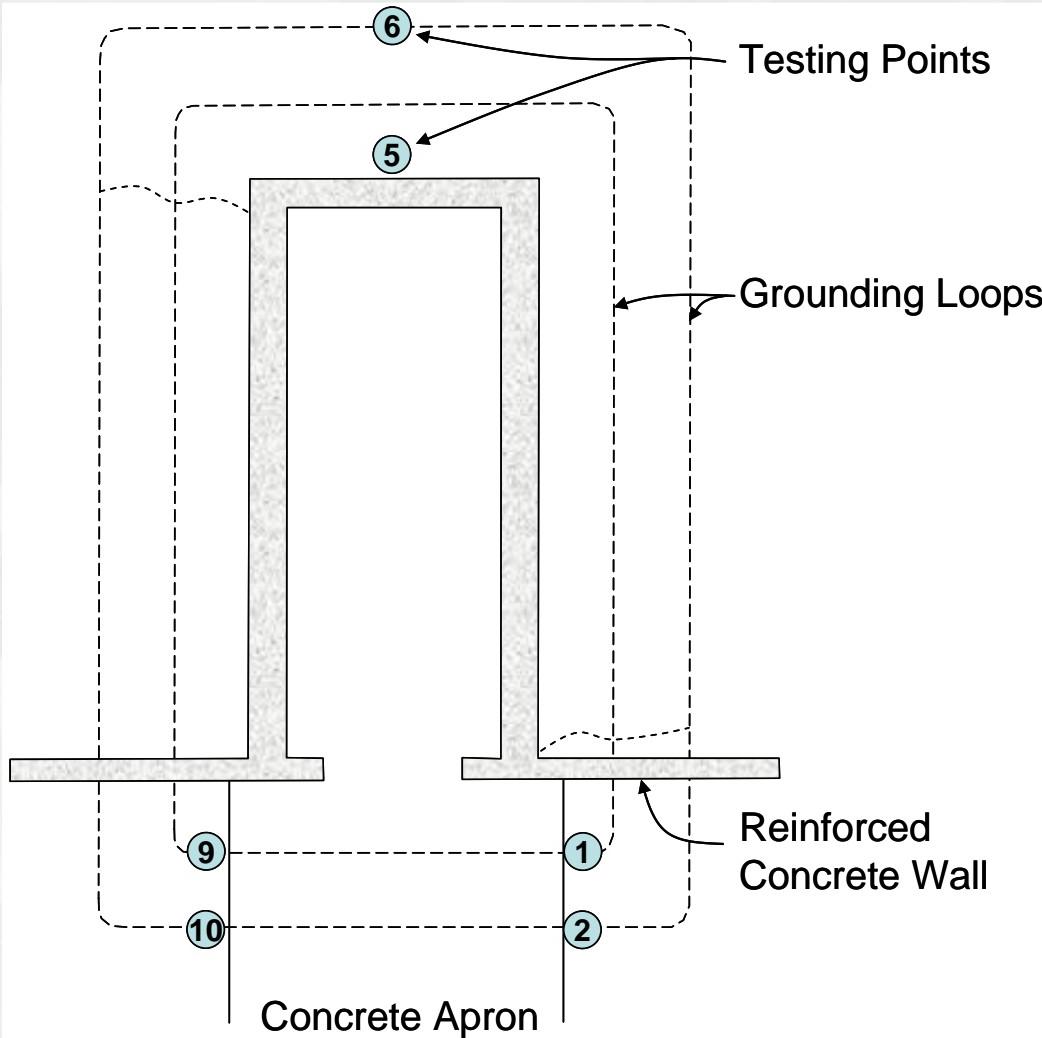
Assumptions:

Current density of 16.15 mA/m²

Steel surface area of 0.524 m²/m²



Field Tests

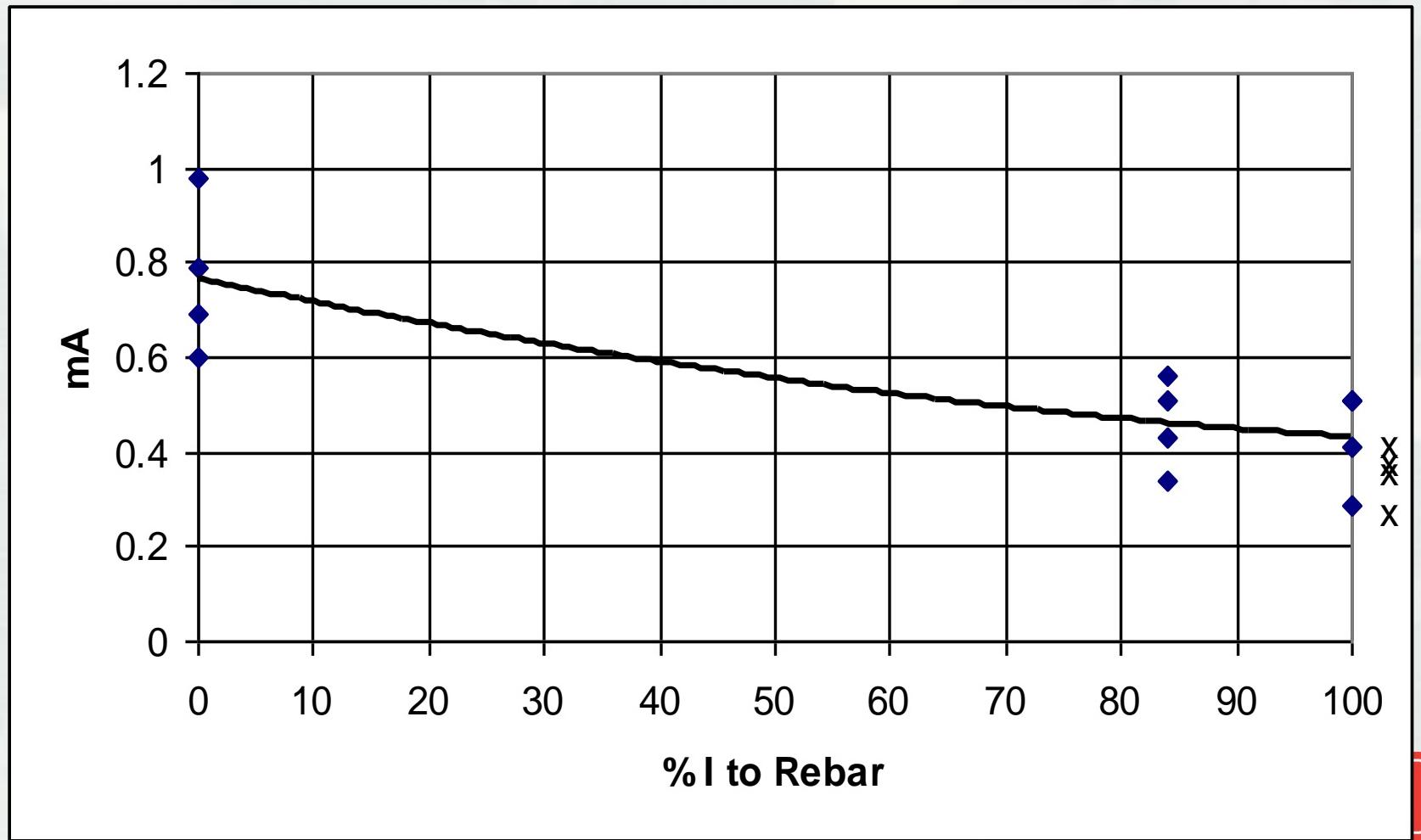


Recommended Field Test Procedure

- Locate “most cathodic” and “most anodic” sites
- Install test probes at “most cathodic” and “most anodic” sites
- Take data with the EOP system off and disconnected
- Take data with the EOP system energized
 - ▶ Selected percentage from 0-100% of the cathodic current diverted to the reinforcing steel
- Plot current and potential data
- Determine potential for Stray Current Corrosion



Plot of Current Measurements



Field Measurements



RF Emission Testing



EM Emission Testing



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Conclusions

- A rebar probe placed above the location of the grounding loops shifted in the anodic direction (corrosive) when attached to the EOP system negative. The anodic shift decreased in magnitude as more current was directed to the reinforcing steel.
- Corrosion current was measured to the rebar probe placed above the location of the grounding loops. The corrosion current decreased in magnitude as more current was directed to the reinforcing steel.



Conclusions

- The corrosive potential and corrosion current recorded when a high percentage of current was directed to the reinforcing steel was not a function of EOP system operation. EOP operated in this way will not cause significant stray current corrosion of elements embedded in the soil.
- With a large percentage of cathodic current directed to the reinforcing steel EOP operation will not result in stray current corrosion of the LPS or structural steel of the magazines.



Discussions



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